

# Fun with Filters



Filter wheel for a telescope

## Introduction:

Astronomers often look at objects in space through filters of different colors. Although this changes how the objects look, it helps them sort out details in the structure and composition of the objects they are looking at. These activities give participants some experience with colored filters and how astronomers use them to understand astronomical objects.

## Part One: Visible light is made up of the colors of the rainbow:

Depending on the age of your youth – they may not yet know much about light. In this activity, they will learn that good ole visible light is energy that contains all of the colors of the rainbow. You can skip this part if your youth are comfortable with these ideas already.

## Materials:

Rainbow Peepholes  
Flashlight

Try to darken the room. Have participants look at the bright led flashlight. Ask them to describe what they see. (light, white light etc.)

Hand out the rainbow peepholes. Now what do they notice when they look at the light? Accept all responses and ask them for possible explanations. Is the light from the flashlight made up of all of these different colors mixed together? **Yes!**

## What's going on?

The Rainbow Peepholes are called diffraction gratings. Diffraction gratings act like a prism and **bend the waves** of light. (It is useful to think of light as being electromagnetic waves.) The waves that make up purple light are bent the most. The waves that make up blue light are bent more than the waves that make up green light. Red light waves are bent the least. In this way, the diffraction gratings separate the white light out into its different wavelengths or colors!

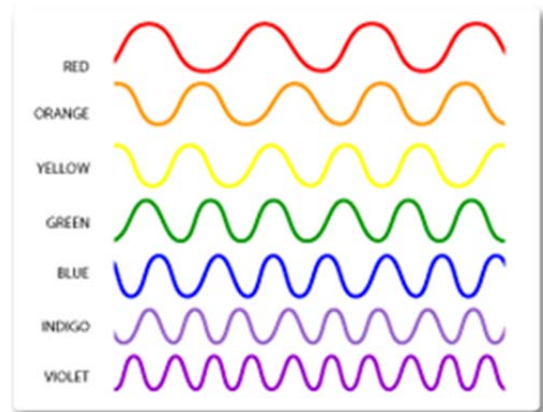


Image from: <http://missionscience.nasa.gov/ems/>

## Part Two: Alien Eyes:

Alien Eyes is derived from the activity: "Seeing through Alien Eyes", originally created by Dennis Schatz (Pacific Science Center), Suzanne Gurton and Dan Zevin for Family Astro and adapted by Anna Hurst.

In this activity, your "subjects" will be aliens from different worlds through "filtered eyes".

## Materials:

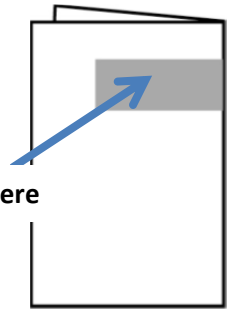
1. Cosmic visors for which you'll need:
  - a. colored filter sheets (use two strip for each visor – they are not of the greatest quality)
  - b. 12 manila folders, or other face masks
  - c. Paper clips for securing cosmic visors
2. PowerPoint presentation of images: <http://skynetjuniorscholars.org/ppts/filters.ppt>

## Making the Cosmic Visors:

Pre-cut the blue, green and red theatrical gel sheets into 3 strips. Trim the ends so that they are about 8 inches long. Fold the strips in half to create strips that are about 1.25 inches wide and 8 inches long and double thickness. You should end up with six of each color. (Save the left over bits- you can cover your flashlight with them in the follow up activity.)

Cut 5 manila folders at their fold. Cut them in half again. Cut a 1" x 7" window in each of these pieces. This can easily be accomplished by folding the face mask in half and making the cuts.

Cut here

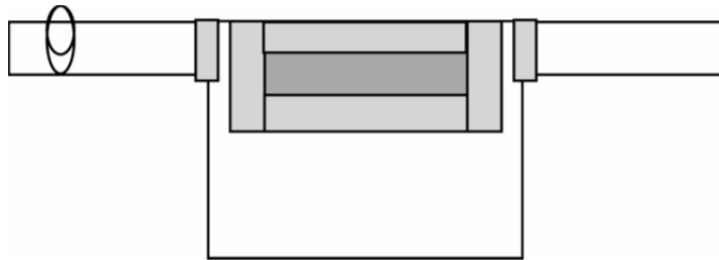


Cover the window by taping a colored gel strip over it on one side. Place tape along all 4 sides.

You can make straps for your visors by using string, ribbons, or rubber bands.

You can also make straps by cutting another set of 5 manila folders (whole, but folded) into eight strips. You should end up with eight strips per folder, and 40 strips total. You will need two strips per visor

Tape one strip to each side of each visor at the top (tape heavily and on both sides to make sure strips are secure and durable). Your Cosmic Visors are now complete. They should be fastened in the back by paper clips to keep them over people's eyes and on their heads.



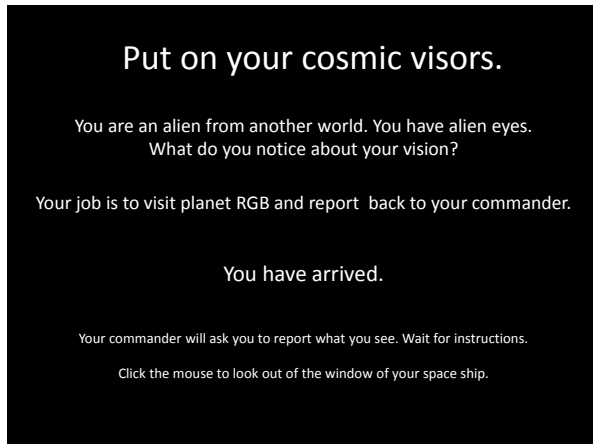
## Doing the Activity:

To introduce this activity, have participants first put on their cosmic visors or filters. Adjust visors so that users can view objects easily through the filters, but it is impossible or difficult to see around the edges of the facemask. When all visors are properly adjusted, let them look around. Have a brief discussion with the participants about how different everything now looks through the visors.

Suggest that this may be how an alien from another planet might see the world. In fact they are Aliens from another world who travel to other planets and report what they see to their commander (That's you!).

Use the PowerPoint presentation to take them on a journey to another world! The following pages contain the PowerPoint slides and associated notes.

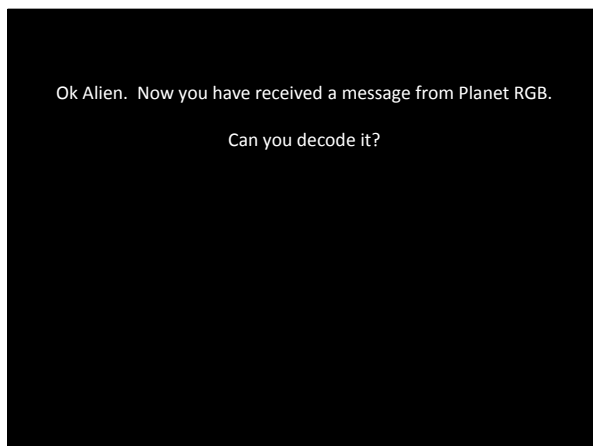
PowerPoint Slides:



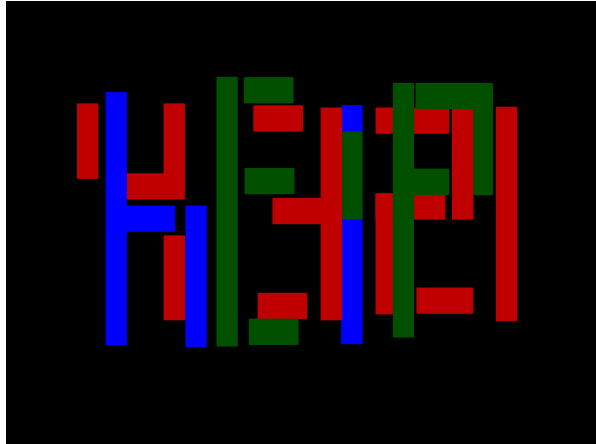
In this activity, you are the commander! Before you begin, make sure all your little aliens put on their filter visors. You can read this slide to them. Ask for comments about their vision, and accept all answers. Then continue reading.



This is the view outside the spaceship window. First, ask the "blue" aliens to describe what they see, then the red aliens, and finally the green. Allow the aliens to discuss why they see different scenes. As the Commander you can say: "Hmm, it appears as though we have some disagreement about the characteristics of this planet. But Wait! We are receiving a message..."



Read this. (On the next slide you will see the message)



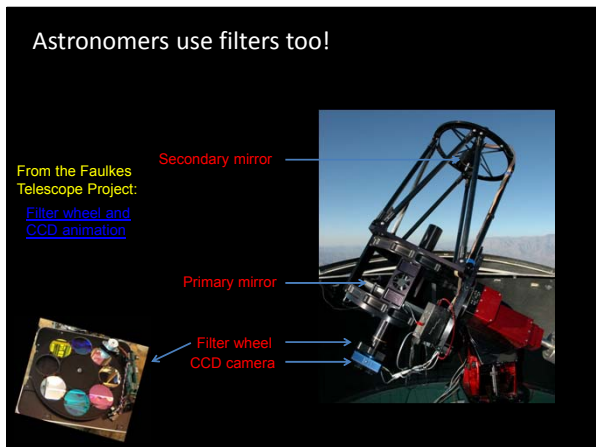
Get responses from the red aliens, the blue aliens and the green aliens. You can say: "Once again we learn different things though different eyes. Red aliens, you see the numbers '4,3,2,1'. Blue Aliens are receiving a nice 'hi'. And green aliens are picking up 'help'. It seems as if your eyes are all very useful!"

You can let your aliens trade filters with each other now. "Your cosmic visors are filters. They let only one color or wavelength of light through. Are they useful in detecting different messages?"



Let participants trade filters again.

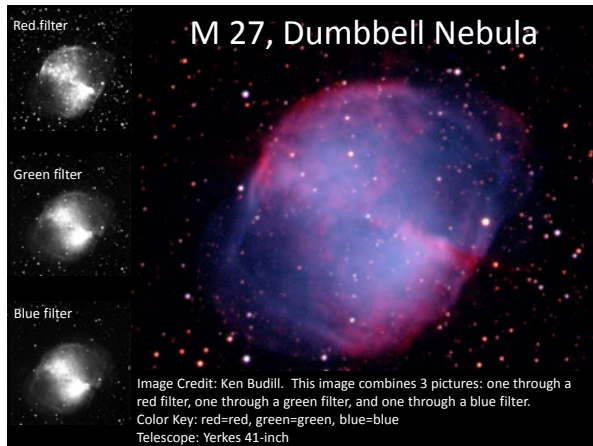
Say: "Notice the white cloud can be seen through all filters. White light is a mixture of all the colors of the rainbow, including red, green and blue!"



Discuss: Filters allow some wavelengths or color of light through and block others. By isolating just one color of light, you can learn which parts of your object – your nebula, star field or galaxy – are shining in only that color.

That helps you discover what causes your object to shine.

There is a neat animation that shows astronomical filters in use here: [http://support.faulkes-telescope.com/multimedia/ccd/CCD\\_Fullscreen.swf](http://support.faulkes-telescope.com/multimedia/ccd/CCD_Fullscreen.swf). It is linked from this slide.



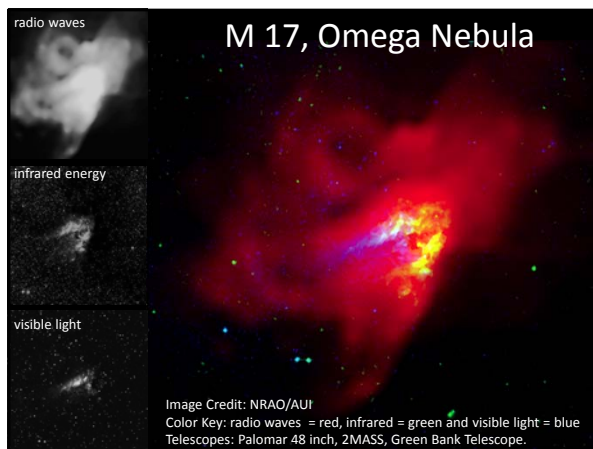
Here is an example of an object as seen through a red, green and blue filter. Does the object look the same in each filter?  
 Note: The data astronomers get after using different filters is shown on the left. Astronomers don't need to turn their images into color pictures to do their science. But, by assigning colors to each image they can combine their data into one interesting and beautiful image!

The Dumbbell Nebula is produced by a dying star. Its outer layers are being ejected in a beautiful expanding shell of gas. This gas is excited by the hot dying star ( find the tiny blue dot in the center of the nebula), and that make it shine. The red light comes from excited hydrogen, and the blue, and green light from excited oxygen.

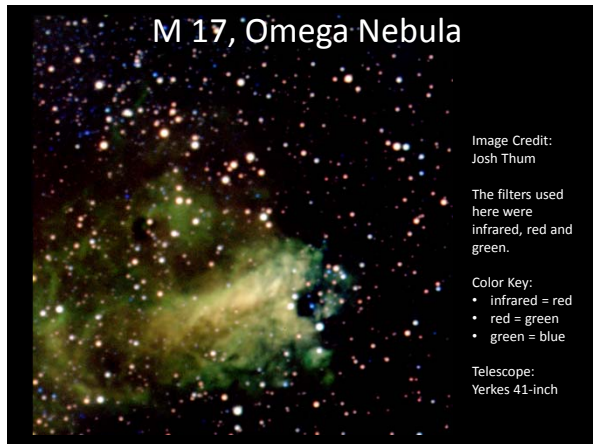
## Representational Images

Astronomers don't just combine images taken through red, green and blue filters. They use narrow-band filters too. They even combine images from very different telescopes like x-ray telescopes and radio telescopes!

For each upcoming image, read what each color represents, and then use your filters to check out the image.



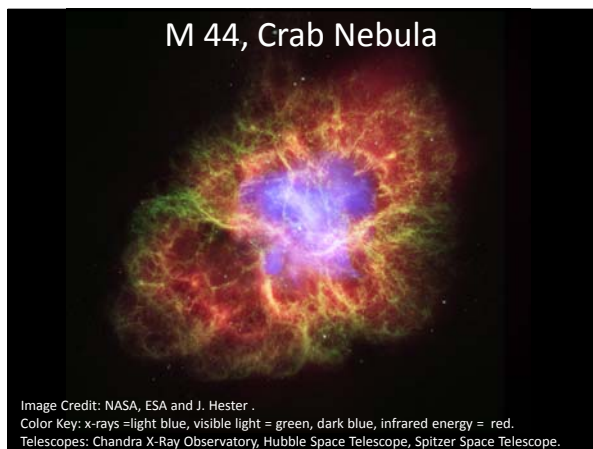
The Omega Nebula is a cloud of gas and dust that is forming new stars.  
 The infrared energy is emitted by dust clouds warmed by new stars in the nebula. The visible light and radio waves are produced when these stars ionize the gas around them.



Here is another image of the Omega Nebula. Astronomers often combine images taken through infrared, red, and green filters. Josh Thum was a middle school student when he took this data!

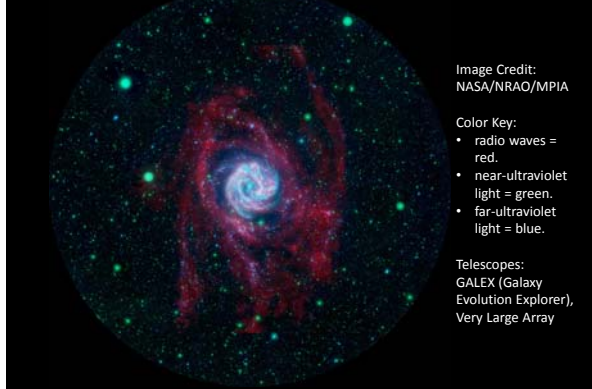


This is another planetary nebula, a shell of gas excited by its dying hot star. The 3 filters are designed to let mere slivers of light through: the light from excited nitrogen gas, hydrogen gas, and oxygen gas.



Here we have another type of nebula; an expanding shell of gas from a supernova explosion. It is called a supernova remnant. The gas you see here shines across the whole spectrum. In this image we see the energy from x-rays, visible light and infrared light.

## M 83, Southern Pinwheel Galaxy



M 83 is a spiral galaxy 15 million light years distant from Earth. In this combined image ultraviolet light and radio waves are displayed—neither radio waves nor ultraviolet are visible to our eyes!

Take home message: Filters block some of the colors or wavelengths of light and let others through. This is useful to astronomers who want to understand properties of cosmic objects.

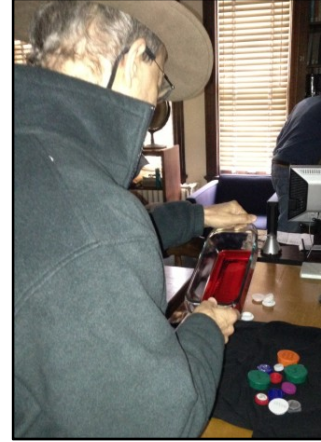
## Follow up:

Revisit Part One of this activity, but now, cover the flashlight with pieces of the colored filters and look at the light with the Rainbow Peepholes.

## Extensions:

### Make your own Filters!

SJS Project Director Vivian Hoette had a brainstorm one day and created red, green and blue filters with Jello! Here's a picture of University of Chicago astronomer Al Harper viewing a "star cluster" (made of colored bottle tops) through a red Jello filter. Wonder what would legos look like? What other kinds of filters can you find or make?



### Tactile Filters.

White light is a mixture of all the colors in the rainbow. Each color represents a different wavelength, where blue light is a shorter wavelength than green or yellow, and red light is longest of all.

You can represent these different wavelengths of light with a nice bird seed mix! Sunflower seeds can represent red light, corn can represent yellow light and tiny millet seeds can be blue. Can you find a "blue filter" that only lets the "blue light" through?

### Detecting light you cannot see.

Your kit contains some white pony beads. When these beads are "activated" they will change color. (I like to hand these out inside and let the kids try to "activate" them. They will rub them, run them under water, you name it!) These are UV beads—UV Beads contain a chemical that changes color when exposed to ultraviolet light. What kinds of light produce UV light? Can UV pass through window glass?

### Reinforce the EM Spectrum by playing electromagnetic war!

The Space Public Outreach Team at Montana State created a fun card game that uses EM spectrum cards! Print on card stock front and back, then cut out to have playing cards. Students can play "Electromagnetic War" to learn about the differences between different types of light. The game can be modified so that highest energy wins, or longest wavelength, or highest frequency. It's played exactly like the card game War.

## Resources:

These resources are also linked from our Resources page:

<http://skynetjuniorscholars.org/resources>

EM Spectrum War Card Template: [http://skynetjuniorscholars.org/pdfs/EM\\_War\\_cards.pdf](http://skynetjuniorscholars.org/pdfs/EM_War_cards.pdf)

Tour of the Electromagnetic Spectrum: <http://missionscience.nasa.gov/ems/index.html>

The Meaning of Color in Hubble Images:

[http://hubblesite.org/gallery/behind\\_the\\_pictures/meaning\\_of\\_color/](http://hubblesite.org/gallery/behind_the_pictures/meaning_of_color/)